State of Wisconsin/Department of Transportation

RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: Dec 31, 2002

Program: SPR-0010(36) FFY99	**Part: II Research and Development**
Project Title: Gyratory Compactor to Measure Mechanical Stability of Asphalt Mixes	**Project ID:** 0092-01-02
Administrative Contact: Nina McLawhorn	**Sponsor:**
WisDOT Technical Contact: Error! Bookmark not defined.	**Approved Starting Date:** Nov 1, 2000
Approved by COR/Steering Committee: $55,337.00	**Approved Ending Date:** Nov 1, 2002
Project Investigator (agency & contact): Hussain Bahia: UW-Madison	

Description: This study will be conducted over 12 months, and will be completed in five (5) phases.
Task 1: Literature and Equipment Design Review
Task 2: Laboratory Study of Field Produced Samples
Task 3: Establish a Mixture Design Criteria
Task 4: Preparing Plans for Future Field Study
Task 5: Prepare and Submit Final Report

Background:
The Superpave volumetric mixture design procedure does not include a measure of mechanical stability of asphalt mixtures. Although there are few efforts at the national level to develop a separate test for measuring a performance property, it is not known whether these efforts will be successful. It is also not know whether such test will be practical enough to be used as a quality control test by the contractors in the field.

Recent research work at the University of Wisconsin-Madison (funded by FHWA in 1998-99) has resulted in developing a simple accessory that can be used to measure internal friction of asphalt mixtures during the compaction process. The simple device has been used to test several mixtures produced in the field by contractors in Wisconsin. The results are very encouraging and show a high potential for success. This research effort has also indicated that the Superpave Gyratory Compactor could be modified to provide the means for measuring the mechanical stiffness and strength at conditions that simulate field conditions under traffic.

There is a need to continue this effort and explore all possible uses of the gyratory compactor to measure frictional resistance of mixtures during compaction and also mechanical stability under traffic conditions. The Wisconsin DOT and the Industry in Wisconsin can benefit of a simple device that is part of the gyratory compactor that can measure performance-related properties of mixtures. Such a device could be used to enhance the mixture design process to include a mechanical stability measure.

Total Study Budget	Current FFY Budget	Expenditures for Current Quarter	Total Expenditures to Date	Percent Complete
$55,337.00	**$18,445.68**	$0.00	**$34,112.86**	**60 (%)**

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Progress This Quarter:
(Includes project committee mtgs, work plan status, contract status, significant progress, etc.)

Rutting Test:

Samples were prepared for the rutting test according to the NCHRP 9-19. The aggregates, the asphalt binders, and the mix design were obtained from the contractors mentioned in previous reports. All the mix designs used in this research have passed SUPERPAVE and WisDOT requirements. For this research 24 mix designs were obtained from the contractors in the state of Wisconsin and for each mix design two samples were compacted and tested for rutting test as they are listed in the following table. This table consists of trusted data after the elimination of erroneous ones

All samples underwent the rutting test and the flow number for each is calculated. The rutting test for the samples were conducted using Cox universal testing machine at the University of Wisconsin-Madison

The research team observed that the obtained flow numbers form the rutting test results were not repeatable. This means that the variation in the results was high even in the same mix design and the same test conditions. The flow number is not a measured value; it is estimated using a fitting model, which could be creating the uncertainty in this measure. Due to the problems with the flow number, alternative approaches were considered to evaluate potential resistance to rutting. The rate of deformation of the samples taken at selected number of repetitions could give a good indication of their performance. This rate was obtained by plotting the vertical strain rate versus the number of cycles and is calculated for the number of cycles within the linear range of the permanent strain versus the number of cycle's charts. Two numbers were calculated, first for the rate of deformation between the cycle 100 and cycle 200, second is the rate between cycle 100 and the cycle corresponding to the change of slope (also indicator of Fn). Table 1 lists all the parameters calculated for the samples tested last quarter. The table also includes the densification parameters (TEI and TFI) that are derived from the gyratory results. This analysis will continue next quarter.

Table 1. Summary of Results Collected to Date.

Source	Sample	Classification	AC		No. GYR	Sample	Flow Number	Power (100-FN)			Power (100-200)			CEI	TEI	CFI	TFI
								Power (100-FN)	Ini.Cyc	Fin.Cyc	Power (100-200)	Ini.Cyc	Fin.Cyc				
P&D	[illegible]	E10	Opt-0.5%	3.80	600	500200-A1T	804	-0.213	100	804	-0.1159	100	200	333.4	816.2	496.9	3103.5
						500200-A2T	252	-0.227	100	252	-0.15260	100	200	368.8	812.7	538.4	3103.5
						500200-A5T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	354.9	587.7	483.7	2229.5
	[illegible]	E-30	Opt-0.5%	3.80	600	500200-2T	2558	-0.371	100.00	2558	-0.15	100.00	200.00	754.0	2224.0	901.0	7308.0
					100	500200-3T	800	-0.483	100	800	-0.1806	100	200	369.7	122.9	505.3	954.1
						500200-4T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	737.6	26.6	885.8	511.2
			Opt	4.30	600	500200-5T	1222	-0.117	100	840	-0.0421	100	200	405.8	932.3	532.2	3264.8
						500200-6T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	421.7	910.9	526.0	3183.7
	[illegible]	E10	Opt-0.5%	4.00	600	510999-1T	2858	-0.369	100	2858	-0.1349	100	200	268.0	600.0	393.0	2157.0
						510999-2T	723	-0.287	100	723	-0.1401	100	200	250.0	548.0	383.0	2007.0
					100	510999_4T	300	-0.206	100	300	-0.1393	100	200	272.0	179.0	376.0	1028.0
			Opt	4.50	600	510999-5T	784	-0.252	100	784	-0.13890	100	200	264.0	521.0	387.0	1843.0
						510999-6T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	276.0	519.0	374.0	1804.0
	[illegible]	E-3	Opt-0.5%	4.10	600	505800-1T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	39.5	2057.9	245.7	6517.6
						505800-2T	548	-0.208	100	548	-0.1192	100	200	154.8	1666.4	296.5	5423.8
					100	505800-3T	352	-0.045	100	352	-0.0554	100	200	175.0	151.5	319.7	1075.8
						505800-4T	153	-0.037	100	153	-0.0256	100	140	137.6	180.4	280.1	1165.1
			Opt	4.60	600	505800-5T	92	-0.079	40	92	-0.0786	40	90	92.4	786.8	193.5	2479.5
						505800-6T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	84.8	852.8	186.0	2720.4
	[illegible]	E3	Opt-0.5%	4.80	600	505900-1T	192	-0.024	90	192	-0.02030	90	180	90.8	1952.7	480.8	7804.8
						505900-2T	248	-0.130	100	248	-0.1048	100	200	270.9	1918.5	501.9	7773.1
					100	505900-3t	270	-0.091	100	270	-0.0788	100	200	247.9	83.2	448.1	919.6
						505900-4T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	356.6	52.3	616.5	816.6
			Opt	5.30	600	505900-5T	130	-0.081	60	130	-0.08120	60	130	112.0	1263.9	218.8	3851.3
						505900-6T	60	-0.090	40	60	-0.09020	40	60	112.0	1263.9	218.8	3851.2
Mathy	[illegible]	E-1	Opt	5.80	600	6006-1T	474	-0.198	100	474	-0.1274	100	200	109.0	1087.0	229.0	1840.0
						6006_2T	1034	-0.153	100	1034	-0.0613	100	200	120.0	1303.0	229.0	1965.0
					100	6006_3T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	98.0	249.0	212.0	1098.0
	[illegible]	E10	Opt	6.20	600	7005-1T	5325	-0.314	100	5325	-0.0827	200	300	394.0	892.0	439.0	1671.0
						7005-2T	371	-0.131	100	371	-0.1310	200	300	359.0	861.0	405.0	1550.0
					100	7005-3T	535	-0.109	100	535	-0.0531	100	200	260.0	256.0	314.0	967.0
P&W	[illegible]	E3	Opt	5.30	600	PW64-1T	558	-0.179	100	558	-0.10370	100	200	91.4	872.7	191.9	2538.4
						PW 64-2T	283	-0.188	100	283	-0.0782	150	250	150.8	1008.0	278.9	2949.9
					100	PW64-3T	650	-0.212	100	650	-0.0961	100	200	124.1	243.5	229.5	1152.8
	[illegible]	E-3	Opt	5.30	600	PW 62-1T	487	-0.078	100	487	-0.0552	100	200	120.4	1305.6	221.6	2871.4
						PW62-2T	264	-0.058	100	264	-0.0512	100	200	150.8	1008.0	278.9	2949.9
					100	PW62-3T	241	-0.085	100	241	-0.0779	100	200	121.3	234.9	232.5	1149.4
Amon	[illegible]	E-3	Opt	5.45	100	108012.5-3T	1753	-0.377	100	1753	-0.1796	100	200	227.9	196.9	322.2	961.9
						108012.5-4T	193	-0.086	90	190	-0.0856	90	190	253.6	194.3	324.5	883.3
	[illegible]	E-3	Opt	5.00	600	15-19-75FPOT-	245	-0.054	800	245	-0.0345	80	180	156.2	729.5	263.0	2331.2
					100	15-19-75FPOT-	304	-0.102	100	304	-0.0957	100	200	134.7	219.4	238.1	1086.0

The values obtained from the strain rate show more repeatability than the flow numbers calculated. However, further statistical analysis is needed to reach a final decision regarding these values because some of the tests did not yield meaningful results. Therefore, more data points may be used from our database to build up a representative population for correlating the rate of deformation with the traffic indices to determine the behavior of the samples

Work Next Quarter:

The analysis of rutting data will continue next quarter to determine the best performance indicator. Once that is completed, the best indicator will be compared to the results from the Gyratory compactor. This analysis could be used to propose a mixture stability parameter to be used in mixture design.

Circumstances affecting progress/budget:

A no cost extension has been requested fro this project to allow completion of analysis and review of final report.

Gantt Chart:

Note: Gantt chart shown in State Fiscal Year Quarters